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ABSTRACT

This paper examines educational applications of computer-based communications to identify unique tools for learning provided by this medium and to identify key features of successful text-based computer mediated communications (CMC) projects. A review of CMC programs provides guidelines for designing effective teacher training programs in CMC. Since institutions of higher learning are significant sponsors of technology training programs for teachers, an additional section addresses the role of higher education in supporting improvements in teacher training programs. Five dependent variables--performance outcomes, cognitive processing, efficiency, equity of access to instruction, and nature of social interaction--and four independent variables--characteristics of the media, student characteristics, instructional method, and social context of learning and instruction--are described in association with media research. It is suggested that a future research agenda should include the amassing of more data to evaluate critically the most appropriate uses and clientele for CMC. (Contains 33 references.) (Author/ALF)

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Computer Mediated Communication: How Does It Change the Social-Psychological Aspects of Teaching and Instruction?

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Abstract

This paper examines educational applications of computer-based communications to identify unique tools for learning provided by this medium and to identify key features of successful computer mediated communications (CMC) projects. A review of CMC programs provides guidelines for designing effective teacher training programs in CMC. Since institutions of higher learning are significant sponsors of technology training programs for teachers, an additional section addresses the role of higher education in supporting improvements in teacher training programs.

Introduction

In 1984 Kiesler, Siegel, and McGuire observed that "... no one can predict in any detail the nature of the transformations that computers will bring, but one aspect of life that will certainly be affected is communication" (p. 1123). Today thousands of school children, adult professionals and hobbyists use computers to send millions of electronic messages, files, and data to colleagues on a daily basis. In fact, computer-based network communication is increasing at the astonishing rate of twenty-five percent per month--an increase which would put every single human being online within a few decades (Barlow, 1992, p. 25). Nonetheless relatively little is known about the social and psychological impact of computer-mediated communications on those who communicate.

The technical aspects of computer-mediated communication (CMC) have made this medium an attractive choice for widely varying purposes including instructional programs and courses (Kaye, 1989). CMC can provide interactive capabilities which are not bound by time and geographic distance, and, compared to the telephone and mail service, electronic communications offer increased flexibility and speed at a significantly reduced cost. Proponents of computer communications claim that the greatest merits of well structured network projects in education are that they help students learn specific content knowledge as well as certain academic skills--especially language skills (Riel, 1991-1992, p. 5). However, such relatively uncritical praise may not recognize the actual impact of CMC - both positive and negative.

In this article we review CMC from the perspective of Richard Clark's premise (1983) that media in and of themselves do not affect learning. Instead we assume that particular unique qualities of any medium including CMC interact with learners' aptitudes and preferences. Our goal is to identify the intrinsic characteristics of CMC and analyze how these media traits tend to interact with the learner, situation of learning, and mode of instruction. This may provide a framework to determine

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educational contexts and objectives for which computer-based interaction may be particularly well suited.

Background

Clark and Sugrue (1991) suggest four key dependent variables as being most frequently studied by media researchers: (1)performance outcomes; (2)cognitive processing (type of learning being measured); (3)efficiency/costs; and (4) equity of access to instruction. While acknowledging that their list of independent variables may be expanded by others, Clark and Sugrue's three main variables are: (1)media characteristics (including type of medium, specific attributes of medium, symbol systems within medium); (2)student characteristics such as general ability, attributions, preferences and prior knowledge; and (3)instructional method such as on-the-job training, lecture, individualized/group instruction, and programmed instruction (Goldstein, 1985).

We believe that CMC research requires some additional conditions for analysis because of the relation between communication context and meaning, an issue not accounted for in Clark and Sugrue's variables. While the technical capabilities of CMC are well documented the social psychological aspects of computer-based communication are not yet clearly understood (Feenberg, 1987; Kiesler et al., 1984; McGuire, Kiesler, & Siegel, 1987; Siegel, Dubrovsky, Kiesler, & McGuire, 1986). Much of the enthusiasm stimulating instructional use of CMC is based on "a shift away from stand-alone computer and individual software packages to technology that is more focused on connecting students and teachers to each other and to the world outside the school walls" (November, 1992, p. 50). In a commentary discussing computer-to-computer conversations, Janet Perrolle (1991) suggests that CMC should be viewed as a social rather than a psychological or cognitive phenomenon and, as such, use of CMC should be carefully planned to establish "nondistorted communication" (p. 23). Therefore, we have added to the Clark and Sugrue framework for media research two variables which address the complexity of the social situation in which the learning occurs. The social context of learning and instruction will be considered an independent variable and the nature of social interaction (descriptive information regarding the kinds, distribution, frequency, and content analysis of social interactions) will be considered a dependent measure used for analysis (See Table 1).

As an initiating statement, we have found that the literature on CMC ranges from enthusiastic testimonials to quasi-experimental studies to a few controlled experiments. The testimonials by classroom teachers and education researchers are helpful in motivating others to consider potential uses for this new instructional medium. However, it is possible that CMC enthusiasts who have not considered each of the media research variables listed in Table 1 may unknowingly be basing their claims of success with CMC on uncontrolled and novelty effects. Quasi-experimental comparisons of CMC with existing instruction also base some of their successful outcomes on uncontrolled factors such as instructional method and student/teacher attitudes. Nonetheless these "real-world," situationally-based application studies (e.g., Beals, 1991; Feenberg, 1987; Kaye, 1989; Quinn, Mehan, Levin, and Black, 1983; Romiszowski, 1990) provide valuable information about CMC technology, its uses, and its potential strengths and weaknesses.

Scientific experiments (e.g., Kiesler et al., 1984; Siegel et al., 1986; McGuire et al., 1987) provide a more solid foundation of knowledge upon which educators can begin to construct an understanding of how CMC can be effectively used as a medium for instruction. However, it is clear that educational application of computer mediated interaction is not easily reduced to scientifically controlled conditions. The primary challenge with social context variables such as those associated with computer-based interactions, is to establish control in order to make comparison with similarly organized face-to-face situations. Because electronic dialogue, at this time, is primarily text-based interchange, it is an ideal medium for conducting social interaction research of this type as the context and structure can be controlled by the discussion moderator and all interactions are archived in electronic text form.

Table 1

Dependent/Independent Variables Associated with Media Research

Dependent Variables	Independent Variables
1) Performance outcomes	1) Media characteristics - type of medium, specific attributes of medium, and symbol systems within medium
2) Cognitive processing - type of learning being measured	2) Student characteristics - including general ability, attributions, preferences, and prior knowledge
3) Efficiency/costs	3) Instructional method such as on-the-job training, lecture, individualized or group instruction, programmed instruction
4) Equity of access to instruction	4) Social context of learning and instruction
5) Nature of social interaction - kind, distribution, frequency, and content analyses.	

Independent Variables

Unique characteristics of this medium. The term computer-mediated communication refers to electronic mail and messages, electronic bulletin board systems, computer conferencing systems, and other forms of computer-based network communications. Here we address only text-based CMC, but state-of-the-art CMC technology can include interactive audio, video, and graphics communications. Because CMC is an emerging technology, research regarding the influence of the characteristics of this medium and their impact will change as new features and capabilities are incorporated into standard CMC technology.

CMC offers previously unimaginable communications access and capabilities. Computer

communications technology enables student and teachers to exchange, store, edit, broadcast, copy, and send written documents instantly, conveniently, and relatively cheaply over short or long distances (Kiesler et al., 1984). Interactions via computer exchanges may be immediate or delayed regardless of the geographic distance between participants. For example, with the use of network technology two or more individuals can view the same document and make simultaneous revisions without meeting face-to-face or using a telephone. Anthony Kaye suggests that CMC "...is essentially a medium of written discourse, which shares some of the spontaneity and flexibility of spoken conversation..." (1990, p. 10). Others (Davie & Wells, 1991; Harasim, 1990) point out that CMC is capable of the speed and interactivity of telephone and face-to-face communication, but lacks the aural and visual cues associated with telephone and person-to-person exchange.

From a physical perspective, computer-to-computer exchanges are based on activities which are very familiar such as keyboarding and printing messages, using standard syntax. We have been "speaking" to others via text messages in traditional print media using such technologies for centuries. It appears that computer-mediation changes the nature of these communications in two ways.

First, the asynchronous nature of computer interactions appears to cause the pattern of discussion in CMC to differ from face-to-face exchanges. CMC responses can be immediate or delayed and may be to one or to many individuals who may be geographically close or on the opposite side of the globe. Face-to-face exchanges tend to be linear so that remarks and replies build from one another. For example, in a class situation matters of procedure tend to be clustered at the beginning and end of classroom lessons (Quinn et al., 1983). In contrast, online discussions are characterized as having "multiple threads" to the discussion and a non-linear pattern. Procedural questions often continue throughout the entire exchange, running parallel to on-going discussion of several other topics (Kaye, 1989; Kiesler et al., 1984; Quinn et al., 1983). This aspect of CMC can be influenced to some extent by the moderator of the discussion who serves a purpose similar to a moderator of face-to-face meetings by keeping the group focussed and on task (Feenberg, 1987). However, CMC clearly makes possible communication patterns not found in face-to-face interactions.

A second unique aspect of CMC is that users of this technology can create their own syntax and lexical symbol system to convey and clarify affective expression; CMC users also can control the timing of communications interactions. Because CMC is primarily limited to text-based interaction and involves a limited social context, users generate electronic analogs of common communication features such as body language and voice inflection. Beals' analysis of first-year teachers' interactions on Harvard's Beginning Teachers Network reports that participants embellished their informal exchanges with "textual displays of what would have been non-verbal cues in face-to-face conversation" (1991, p. 76). Other CMC researchers (Kiesler et al., 1984) also report use of exaggerated punctuation and lexical symbols in electronic mail and computer conference exchanges to convey tone and gesture cues to the reader. It appears that these contextual aspects of communication are sufficiently important to establishing meaning that creative adaptations have generated symbols to reduce the contextual sterility of CMC. As for timing, CMC users can respond on a personal time schedule. As a result, it appears that CMC communications can be subjected to different types of consideration from the sender and can evoke different types of responses than face-

to-face.

Student characteristics. Margaret Riel (1991-1992) points out that failures to create effective electronic projects by and large go unreported. It may be that most of the reports on network projects are biased by the self-selection of their creators and participants. The classroom study conducted by Quinn et al. (1983) found that anxiety about using a computer was a significant factor to consider when introducing a new computer-based medium to adults. It appears that those have some fear or negative feelings towards using computers self-select themselves out of CMC projects whenever possible. The same report by Quinn, et al. (1983) found that computer anxiety was not factor when introducing computer technology to elementary-age children, and computer anxiety may be much less common today than it was ten years ago.

In her report on participants' reactions to the delay in response time to online interactions, Beals (1991) found that some participants felt that the time lag allowed more time to think and to feel safer before responding. Other participants reported that the delay in receiving responses made them feel "less engaged" in the discussion. Investigations of the level of involvement and attentiveness of participants in face-to-face versus electronic message systems verses computer conference system among familiar and anonymous exchanges indicate that individuals are less psychologically aroused when viewing anonymous postings (Kiesler et al., 1984).

Unanswered questions remain regarding how CMC exchanges are influenced by the tendency of the medium to redirect the users attention from their audience and under what circumstances and for what individuals CMC may tend to stimulate feelings of dehumanization and detachment. The documented increase in uninhibited verbal behavior such as "flaming" in computer-based conferences also reflects a decreased awareness of audience in electronic interactions. The above conditions were found in text-only communication. More sophisticated technologies may provide more social cues by creating conditions more similar to face-to-face exchanges. Nonetheless, it appears that CMC does influence the pace, duration, and content of communication as well as the affective quality of messages.

Instructional method. Clark and Sugrue (1991; Clark, 1983) suggest that conclusions from media research are frequently confounded by two factors: (1)uncontrolled effects caused by variations in instructional method or content differences and (2)novelty effects associated with newer media which tend to disappear over time. Particular attention must be given to these factors in any comparison of CMC with traditional instructional media because online learning is a currently popular medium and is receiving a lot of attention at this time.

Whether the instructional method used is situationally-based (such as on-the-job training), individualized or mass produced programmed instruction, CMC is a viable choice for instructional delivery. Pilot research by Britain's Free University indicates that use of CMC provides a means for enriching home-bound students' interaction with their tutor and fellow students. Instructional media selection relies on an accurate assessment of the need for visual, audio, sensory, hands-on practice, demonstration and discussion/interaction. Kaye (1989) suggests that the additional costs associated with establishing and managing CMC versus traditional distant learning media should be compared

with the benefits of increased interaction with instructor and fellow students. Frequently educational applications of new technology stimulate creative instructional methods for delivering information. The new instructional methods such as greater student-to-student interaction is not medium-dependent, but may reflect capabilities of a given medium which make alternative teaching styles more apparent and more manageable (Feenberg, 1987).

Definition of social context. Just like the traditional classroom, a particular electronic community has its own social milieu. The goals and objectives which inaugurated a group also play a continuing role in affecting the social structure of the group as does each individual participant's attitudes towards the group.

In Tombaugh's (1984) study of a technical expert discussion group, the more highly regarded scientists enrolled in the conference group reported that they were too busy to participate in the on-going group interactions and were less motivated to respond to the continuing electronic dialogue. Other (less individually prominent) participants tended to direct their questions and comments to the more prestigious participants. The failure of this social interaction has many possible explanations; but, it is obvious that the prominent scientists did not share a common purpose with their lesser known colleagues. In addition, many of the scientists were reluctant to share unpublished research over the network. This mistrust among group members reported by Tombaugh is not a medium dependent problem; but, it does reflect the social problems resulting from issues not clearly discussed or resolved among members of any group.

Thus, it may be that context in CMC is the product of stated agreements or time-based informal negotiations just as in face-to-face communication. The absence of context cues, however, may increase the importance of context agreements for successful communication that includes considerable interaction and/or revelation of personal or proprietary information.

Other complexities associated with face-to-face group activities that also occur in CMC interactions are evidenced in different ways. Because computer-based interaction is capable of a variety of time and space configurations for interactions, the structure of CMC discussions is more complex than face-to-face exchange. Computer discussions typically exhibit multi-level topical themes being discussed simultaneously at varying rates of response by participants (Romiszowski & de Hass, 1989). This suggests that the social context in which CMC discourse occurs exhibits a unique structure and characteristics of interactions which may be physically impossible to replicate via other communication media.

Dependent variables

Performance outcomes(type of testing/assessment of learning). Several applications of CMC projects measure student performance outcome variables to determine whether students who have learned content material via CMC show similar performance outcomes as their peers who have been through face-to-face interaction. Quinn et al. (1983) found no significant differences in CMC versus student face-to-face scores on tests of course content, but the nature of student-to-student, teacher-to-student, and student-to-student interactions differed. Thus, in this case, different instructional media

with different patterns and content of interactions yielded basically similar performance outcomes. In contrast, Kiesler et al. (1984) and Siegel (1986) used previously tested group decision-making tasks to compare CMC versus face-to-face interaction. These studies of CMC showed that the outcome of group decision-making was significantly influenced by the type of media available for group communication. The CMC groups tended to make less predictable decisions than the face-to-face groups.

The results of these studies appear to be inconsistent and suggest that further research is needed to determine more about how learning via CMC affects learning outcomes. However, it may be that differences in outcomes are dependent on the nature of the task; the research above suggests that higher order learning skills such as decision-making and problem solving are more affected by the social context associated with the instructional delivery method.

Cognitive processing (type of learning). Riel (1991-1992), Davie and Wells (1991), and Goldman and Newman (in Roberts,Blakeslee, Brown, & Lenk, 1990, p. 99) described the majority of CMC projects as having markedly different objectives from traditional curriculum programs. They point out that CMC projects typically require cross-curricular skills in problem solving tasks. Goldman and Newman suggest that CMC is most effective as a tool to enrich the classroom learning experience in the following five situations: (1)identified topics and group conferences; (2)non-competitive activities; (3)questions that require more reflection; (4)questions where answers are wanted from several students; and (5)private interactions. In addition, Goldman and Newman propose that electronic communication is not an appropriate tool for teaching new concepts that require intense, fast-paced interactions.

Efficiency/costs. Educational applications of CMC have been found to be fast, relatively inexpensive, and convenient (Beals, 1991). The true test of the cost efficiency of using CMC is addressed in Riel's (1991-1992) question for designers of network projects to answer: Is the time invested in network activities matched by significant return in student learning or teacher development? To some extent individual teachers and school systems will have to answer this question based on their student needs and budgetary restrictions. Attempts to answer this question will be highly speculative until a sufficient database is developed from which careful comparison can be made.

Equality of access to instruction. From a purely technical perspective, CMC is attractive to many because it can be an extremely rapid and efficient way of transmitting information. However, the greater convenience afforded by CMC comes only after all the technical skills needed to use CMC have been mastered. CMC research available at this time rarely considers the current technical requirements to establish an efficient network system described by one network expert as being "not for the technically timid" (W. Sanders, personal communications, September xx, 1991). Frustrations due to technical naivete and the lack of support personnel have resulted in some new users never achieving the necessary level of proficiency in their system or personal skills to surmount technical difficulties.

Some users of CMC are not counted in CMC research because they have been eliminated by self-

selective withdrawal (Riel, 1991-1992). For others, the problem is more lack of convenient or any access to the necessary hardware to build a network workstation (Tombaugh, 1984). Thus we find both personal and technical issues that have an impact on access and the influence of both issues is not clear.

Description of social interactions. Several variables that appear consistently throughout the research on social aspects of CMC are: degree of equality of participation, degree of uninhibited verbal behavior, length of response, and pattern of communication among group members. Generally CMC interactions are more equally distributed among group members, but the structure of the group and active presence of a group moderator can affect patterns of communication between group members (Kiesler et al., 1984; Siegel, et al., 1986; Quinn et al., 1983; Tombaugh, 1984). It must also be remembered that CMC typically includes a very select group due to their skill and hardware access. Nonetheless, individuals exhibit more uninhibited verbal behavior in CMC exchanges than in face-to-face interaction (Kiesler et al., 1984; Siegel et al., 1986). And, responses via electronic communication tend to be longer than in face-to-face communication. Quinn et al. (1983) found that the normal pattern of classroom question and response was different in CMC exchanges, in that more student-to-student interaction occurred, as well as less frequent overt evaluation of student comments by the instructor.

In their study of group processes and CMC Siegel, Dubrovsky, Kiesler, and McGuire (1986) reported greater equality of participation and greater shift in choice in the computer-based discussion than in face-to-face interaction. These researchers also found that CMC group decisions deviated more from initial individual preferences than the face-to-face group. This finding lead these investigators to speculate that some people will respond differently in different communication settings. The lack of nonverbal or auditory cues available in current electronic communications systems seem to result in participants feeling more detached from the communications.

Tombaugh's study of an international scientific computer-based conference did not exhibit the equality of participation evidenced in nearly every other CMC study. Participants felt that the lack of structure and need for a group moderator would have corrected this situation. Tombaugh also reported that the CMC conference tended to have many more readers than contributors. This is true of many electronic communications; that is many more messages are sent than are received (Huff, Sproull, and Kiesler, 1989). It does appear that there is sufficient evidence from research and theory to suspect that CMC will indeed influence the nature of social interactions. The degree, direction, and importance of these changes could be a significant factor to consider in assessing uses of CMC.

Future Research Agenda

It is important to note that the current literature on CMC is far from rich. The vast majority of writing is descriptive and testimonial in nature. This is augmented by a group of evaluation studies that primarily report instructor observations and participant reports regarding CMC projects. A very small portion of this literature approaches the standards required for conceptually careful and controlled investigations of CMC variables. Consequently, conclusions about CMC must be weighed carefully in regard to claims advanced and research support.

The current CMC literature points toward the need to investigate additional factors under the broad heading of on-going media research with online learning and electronic communities. A recent electronic report by Cole, Beam, Karn, & Hoad-Reddick (1992) provides a brief summary of current CMC research including: Using a concept mapping tool to assess problem solving strategies among small network groups (Heeren, E.); Identifying relationships between communication media and personality type (Carroll, R., & R. Schipke); Use of CMC to facilitate seminar participation and active thinking (Shedletsky, L.); Exploration of ways to conduct online "focus group" interviews (Robertson, J.); Use of online communication as an enrichment resource for adolescents with disabilities (Lang, S.); and Assessing the effectiveness of CMC to provide scientific role models to under represented groups (Murfin,B.). Each includes the interactive, social aspects of CMC as dependent measures being analyzed in the investigations. Consequently, we should soon begin to amass more data to evaluate critically the most appropriate uses and clientele for CMC.

One of the most exciting outcomes of CMC research is finding that this new medium has provided new insight into the complexity and power of live face-to-face interaction. In addition, research has demonstrated the potential for valuable local and geographically distant interaction via CMC. Obviously, as Christopher O'Malley (1991) prophesies, there will not be a single best instructional use of CMC or any other technology. Existing technologies are not made obsolete by new media, but all modes of instruction should be updated as needs, facilities, and student interests change and new knowledge emerges. However, it is important for research to expand and become more sophisticated. The limited number of studies, restricted as they are to select subjects and settings, provide a relatively modest database from which only the most tentative conclusions may be drawn.

We believe that CMC should be viewed as an opportunity for new development and understanding. As Herbert Simon (1987) so eloquently said, "We have to think about technology in terms of human knowledge...new technology is simply new knowledge; and as such, it resides not in machines but in the human brains that invent them, develop them, and use them." Thus, by putting CMC to use in various ways and carefully considering the characteristics of the medium, the aptitudes and preferences of the students involved, the appropriate instructional method, and the social context in which the instruction and learning are to occur, we shall expand our knowledge about learning and consequently about ourselves as well.

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